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Just how inhomogeneous is the solar corona?

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Over the past several decades the resolution of instruments (Skylab, Yohkoh, SoHO, TRACE, WIND) for observing the solar corona has improved by several orders of magnitude[1], but it always seem to be the case that interesting structures are observed near the limit of resolution. Indirect methods of detecting inhomogeneities in the corona, notably observations of scintillations as background sources pass near the Sun, also imply structures on the smallest scale resolvable. This raises the question posed in the title.I review some older results from solar radioastronomy that suggest inhomogeneoities on very small scales and I attempt to estimate these scales. The observations relate to the polarization and directivity of solar radio bursts. Simple theory implies that fundamental plasma emission should be 100\% polarized in the sense of the o~mode, and this is usually, but not always, the case with type~I emission, but never the case for type~II and type~III emissions. The most plausible depolarization mechanism requires reflection off sharply bounded density structures, and specific models have been suggested for both type~I burst[2] and type~III bursts[3]. The data on type~IV emission from loop footpoints requires that mode coupling be strong whereas simple theory suggests that it should be weak[4]. Again small-scale inhomogeneities seem to be required[5].

I quantify what is required by `sharply bounded' and `small scale' in this context by considering the theory of mode coupling. Sharply bounded requires large coupling coupling coefficients between oppositely directed modes, and this requires a large gradient in relevant magnetoionic parameters. I also quantify the requirements on the inhomogeneities for mode coupling to be strong enough for the polarization of the two footpoints in type~IV emission to be oppositely circularly polarized, as observed.

References

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